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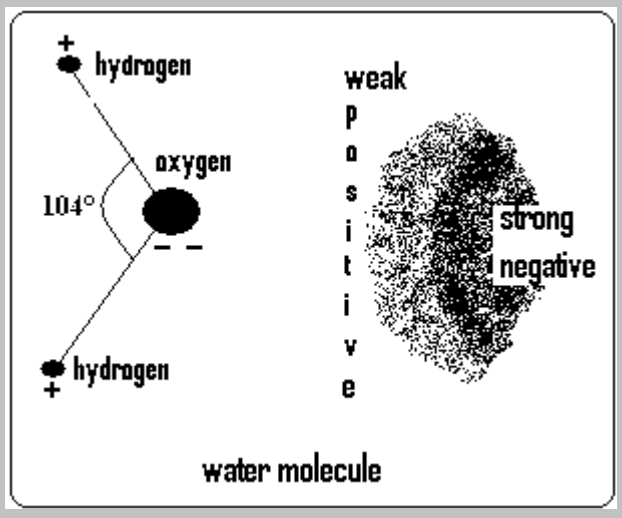
Soap gets the party going

A bit of soap helps dislodge stubborn things that do not dissolve in water, notes S.Ananthanarayanan.

The ancient art of soap making breaks up a molecule of oil, to separate glycerine and leave ‘fatty acids’, which get water-insoluble things to mix more easily with water.

Water soluble things

The reason that some things dissolve in water is that water favours mixing with things that are ‘charged’. The water molecule, H_2O, consists of an oxygen atom and 2 hydrogen atoms. The atoms are themselves a core, or nucleus with a positive charge, surrounded by a cloud of tiny electrons, with negative charges to balance the charge of the nucleus. The oxygen atom, however, has a much greater charge at the centre and a whole lot of electrons all around.



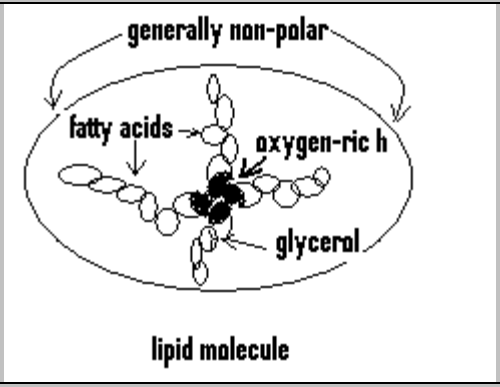
When it combines with 2 hydrogen atoms, which have only electron each, the distribution is with the oxygen nucleus in the middle and the two hydrogen nuclei on the sides, not symmetrically, but at an angle like a clip, like in the picture.
Such a molecule, whose charges not in a line, would be attracted or repelled by things that are charged + or -, like even other molecules of water, but not by with things that are not charged

Now, things like salt, which is an atom of sodium and an atom of chlorine, sticking together because the first has ‘donated’ a negative charge to the other, exist in solution as separated charged particles, but held together because of their opposite charges. When such substances are in a medium of water, the charged fragments can fit into the charged mosaic that the water molecules create, thereby balancing the overall tension of charges. This is the state where we say the substance has ‘dissolved’ – and salts and acids, which are also ‘ionised’, or where charged parts are separated, like salt, are soluble in water.

Organic solvents

The carbon atom, unlike oxygen, combines with 4 hydrogen or other atoms. This makes the whole thing very symmetrical and carbon based molecules usually show no ‘polarity’ and they prefer to mingle with other, similar, non-polarised things.

Fats and oils, or lipids, as they are called, consist of ‘molecules of fatty acids’ and glycerol, an alcohol. Acids and alcohols have a part in their structure where oxygen molecules are important and the molecules become ‘polar’. The operative part in alcohol molecules, in fact, can attach with the operative part of an acid and ‘neutralise’ charge on the acid.molecules.

Glycerol has three such portions and it attaches to 3 molecules of fatty acid and the group, as a whole, then behaves in a non-polar manner, the oxygen rich part being hidden deep inside. These are the oil molecules, the ‘triglycerides’ that we hear of doctors checking for in blood tests. These molecules, then, are not soluble in water, but do dissolve in carbon based, or organic solvents, like petrol.	

Lye as soap

Caustic soda, or lye, was first used to break up triglycerides into water-soluble fatty acids and glycerol. The first use of lye as a detergent, in fact, was to clean wool fibres of the fat of the sheep’s body, so that the fibres could be more easily dyed.

It was soon found that if the glycerol was run off and the fatty acids collected, this made an even more effective agent to get oils to mix with water.

The fatty acid is a large organic molecule with an oxygen rich part at one end, which makes the whole molecule ‘polar’ and soluble in water. But at the same time, the large organic part is able to penetrate globules of oils and fit them with somewhat ‘polar’ protuberances. This action breaks the oils into very tiny droplets that do mix with water, although they do not dissolve, in the sense that salts and acids dissolve. But an intimate mixture, called an ‘emulsion’ is formed, and that is enough to wash the greasy oils away.